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(54) Title: HIGH-FREQUENCY WIDEBAND TUNER

(57) Abstract

High-frequency wideband tuner for converting signals in an r.f. frequency band ranging from frequency f(1) to a frequency f(2) in an intermediate frequency signal having a fixed frequency f(if), comprising a tunable r.f. bandpass filter, an oscillator and a mixer stage which mixer stage has a first input for the output signal of the bandpass filter and a second input for a signal produced by the oscillator, in which the first bandpass filter has a passband from f(1)-f(x), a second bandpass filter is included having a passband from f(x)-f(2) and switching means are included for connecting, as selected, the output signal of the first or the second bandpass filter to the first input of the mixer stage. The oscillator being tuned over a frequency range from f(1)+f(if) to f(x)+f(if) if the mixer stage is connected to the first bandpass filter and over a frequency range from f(x)-f(if) to f(2)-f(if) if the mixer stage is connected to the second bandpass filter. By a combination of the double heterodyne and the single heterodyne principle, a tuner according to the invention particularly for satellite reception is realised in a simple manner, which tuner has a tuning range, for example, from 950-2750 MHz, which thus far has been impossible to cover with a single tuner.

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High-frequency wideband tuner.

The invention relates to a high-frequency wideband tuner for converting signals in an radio-frequency (r.f.) band that ranges from a frequency f(1) to a frequency f(2) in an intermediate frequency signal having a fixed frequency f(if), comprising a tunable r.f. bandpass filter, an oscillator and a mixer stage which has a first input for the output signal of the bandpass filter and a second input for the signal produced by the oscillator. The invention specifically relates to a tuner for signals transmitted by broadcasting satellites.

Such a tuner is described in the article "Television Broadcasting from Satellites" by D.B. Spencer in Wireless World, March 1974, pp. 39-44. This article particularly relates to the problems with respect to image frequencies which may occur in this type of tuners. The frequency band used by the broadcasting satellites may currently range from 10.95 to 12.75 GHz and to date it is customary for this frequency band to be split up at the satellite antenna into a band from 10.95-11.7 GHz which is converted to an intermediate frequency band from 9.50-1700 MHz by a first low noise converter (LNC) whose oscillator has a 10 GHz frequency, and to a band from 11.7-12.75 GHz which is converted to an intermediate frequency band from 950-2000 MHz by a second low noise converter (LNC) whose oscillator has a 10.75 GHz frequency. The two intermediate frequency bands thus obtained are applied to a tuner having a tuning range from 950-2000 MHz which produces for its output signal the television signal transmitted by the satellite. The use of two expensive low noise converters or a switchable CNC, which is also expensive, renders the proposal made in this article economically unattractive.

If the frequency band from 10.95-12.75 GHz as a whole is converted to a first intermediate frequency band from 950-2750 MHz by a low noise converter whose oscillator has a 10 GHz frequency, a tuner is to be used which can cover this range completely and which can convert the signal in this band to a second intermediate frequency signal having a frequency of, for example, 479.5 MHz (the second intermediate frequency determined to be used in Europe). Such a tuner is unavailable for the moment and, with a conventional design for a tuner, cannot be realised either, because the oscillator of such a conventional tuner would have to have a frequency range from 1429.5-3229.5 MHz, which is even hard to realise with three varicaps, but would also have to contain a tunable bandpass

filter for the range from 950-2750 MHz, which cannot (yet) be realised with the techniques currently available. Another option is to provide a twofold tuner comprising two bandpass filters, two mixer stages and two oscillators, in which there are adjacent frequency ranges and they together cover the desired frequency band. Obviously, such a solution is extra costly due to the twofold configuration of a number of high-frequency circuits which are costly by themselves.

It is an object of the invention to provide a tuner covering the entire frequency range from 950-2750 MHz and which can be manufactured economically.

For this purpose the invention comprises a tuner of said type,

The invention is based on the recognition that an oscillator having a limited frequency range (about 2xf(if)) can be used in combination with a pair of tunable bandpass filters which have each a limited frequency range, if the output signal of the first bandpass filter is converted to the desired intermediate frequency signal by the implementation of the double heterodyne principle and the output signal of the second bandpass filter is converted to the same intermediate frequency signal by the implementation of the single heterodyne principle.

The invention will be further explained below with the aid of an embodiment while reference is made to the drawing in which the sole Figure diagrammatically shows a tuner according to the invention.

Reference character 1 in the drawing Figure denotes a satellite dish antenna arranged for receiving television signals in a frequency band, for example, from 10.95 GHz to 12.75 GHz. The signal received by antenna 1 is applied *via* an amplifier 2 to a first input of a mixer stage i.e. mixer 3, whose second input receives the output signal of an oscillator 4 which has, for example, a fixed frequency of 10 GHz. The amplifier 2, mixer 3 and oscillator 4 together form a low noise converter LNC 5. The output signal of the LNC 5, which then has a frequency range from 950-2750 MHz, is applied to a tuner according to the invention, which tuner as a whole is denoted by reference character 6.

The tuner 6 comprises a first tunable bandpass filter 7 and a second tunable bandpass filter 8. The output signal of either filter 7 or 8 may be applied *via* switch 9 to a first input of a mixer 10 whose second input receives the output signal of the tunable oscillator 11. The output signal 12 of the mixer 10 forms the desired intermediate frequency output signal which may further be converted to the desired television signal by a conventional intermediate frequency stage.

The operation of the tuner 6 will be clarified with a numerical example,

there being emphasized that the frequencies to be mentioned below, but also mentioned previously, are given merely for explanatory purposes and that the tuner according to the invention can be used in all those cases where there is a need for a tuner having such a large frequency range that cannot be covered at all or only in an economically unattractive manner with a conventional tuner.

The signal produced by the LNC 5 and having a frequency range from 950-2750 MHz is applied to the filters 7 and 8. It is assumed that the filter 7 has a tuning range from 950-1850 MHz and the filter 8 a tuning range from 1850-2750 MHz. The transition frequency of 1850 MHz, however, may also be, for example, 1750 or 2000 MHz. If the first terminal of mixer 10 is connected to the output of filter 7 *via* switch 9, the oscillator frequency is varied in a conventional manner from 1429.5 to 2329.5 MHz *i.e.* the second intermediate frequency, 479.5 MHz, above the 950-1850 MHz tuning range so as to convert this frequency band to the second intermediate frequency by implementing the double heterodyne principle. However, if the first input terminal of mixer 10 is connected to the output of filter 8 *via* switch 9, the oscillator frequency is varied from 1370.5 to 2270.5 MHz *i.e.* the second intermediate frequency, 479.5 MHz, below the 1850-2750 MHz tuning range so as to convert this frequency band to the second intermediate frequency by implementing the single heterodyne principle. As a result of these measures the oscillator 11 needs to have only a frequency range from 1370.5-2329.5 MHz which can easily be realised with an oscillator comprising a varicap, so that still the whole frequency range from 950-2750 MHz can be covered. Either of the tunable filters 7 and 8 has a limited frequency range too, so that these filters too can be realised simply and economically. *In lieu of* two separate bandpass filters 7 and 8 it is obviously possible to utilize a single filter which can be switched to either desired adjacent frequency band.

The image frequencies of the lower frequency band are situated in the high-frequency band and *vice versa*. To guarantee a proper image frequency suppression it is necessary for that matter for the switch 9 to have a high isolation value even with very high frequencies. A more attractive solution to this problem is to attenuate additionally the filter not being used or retune it to a frequency that does not coincide with the image frequency of the selected band. This may be realised by applying a 0 volts control voltage to the varicaps available in the filter not being used, so that the filter is tuned to the lowest frequency of that particular band where there is no image frequency of the other band available.

By implementing the single heterodyne principle, the television signal available in the frequency band from 1850-2750 MHz is inverted relative to the signal from

the other, lower, frequency band which is converted in a conventional manner. However, this problem may simply be solved by including an inverter circuit in the signal path downstream of the tuner, which inverter circuit is then only activated if filter 8 applies its output signal in the high-frequency band to the mixer 10.

Claims:

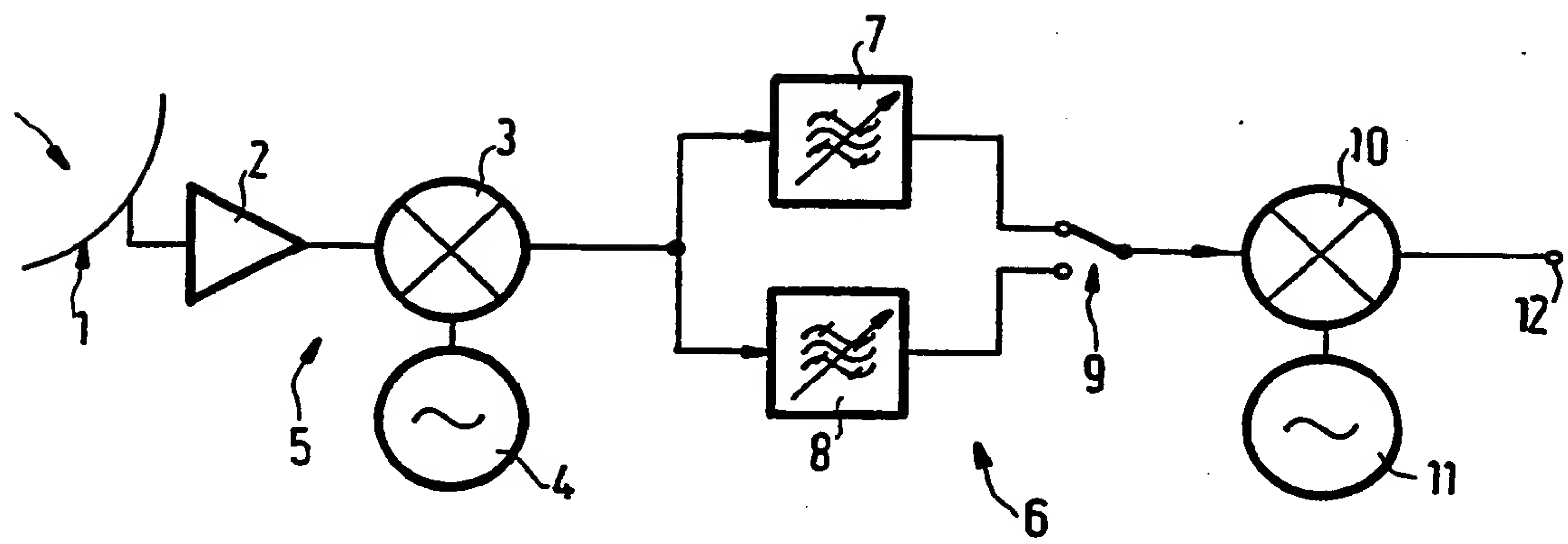
1. High-frequency wideband tuner for converting signals in an radio-frequency (r.f.) band that ranges from a frequency f(1) to a frequency f(2) in an intermediate frequency signal having a fixed frequency f(if), comprising a tunable r.f. bandpass filter, an oscillator and a mixer stage which has a first input for the output signal of the bandpass filter and a second input for the signal produced by the oscillator, characterized in that the first bandpass filter has a passband from f(1)-f(x), in that a second bandpass filter having a passband from f(x)-f(2) is provided as well as switching means for optionally connecting the output signal of the first or of the second bandpass filter to the first input of the mixer stage, the oscillator being tuned over a frequency range from f(1)+f(if) to f(x)+f(if) if the mixer stage is connected to the first bandpass filter and over a frequency range from f(x)-f(if) to f(2)-f(if) if the mixer stage is connected to the second bandpass filter.

2. Tuner as claimed in Claim 1, characterized in that means are provided for always attenuating one bandpass filter if the other bandpass filter is coupled to the mixer stage.

3. Tuner as claimed in Claim 1, characterized in that in that tuning means are provided for always tuning one bandpass filter to a frequency at the bottom of its frequency range if the other bandpass filter is coupled to the mixer stage.

4. Tuner as claimed in one of the Claims 1 to 3, characterized in that an inverter means is coupled to the output of the mixer stage, for inverting the mixer stage output signal, this inverter means being active only if the output signal of the second bandpass filter is applied to the mixer stage.

5. Satellite receiver comprising a low noise converter for converting the signal received by the satellite antenna to an r.f. signal which ranges from a frequency f(1) to a frequency f(2) and comprises a tuner as claimed in one of the Claims 1-4.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(81) Designated States: JP, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

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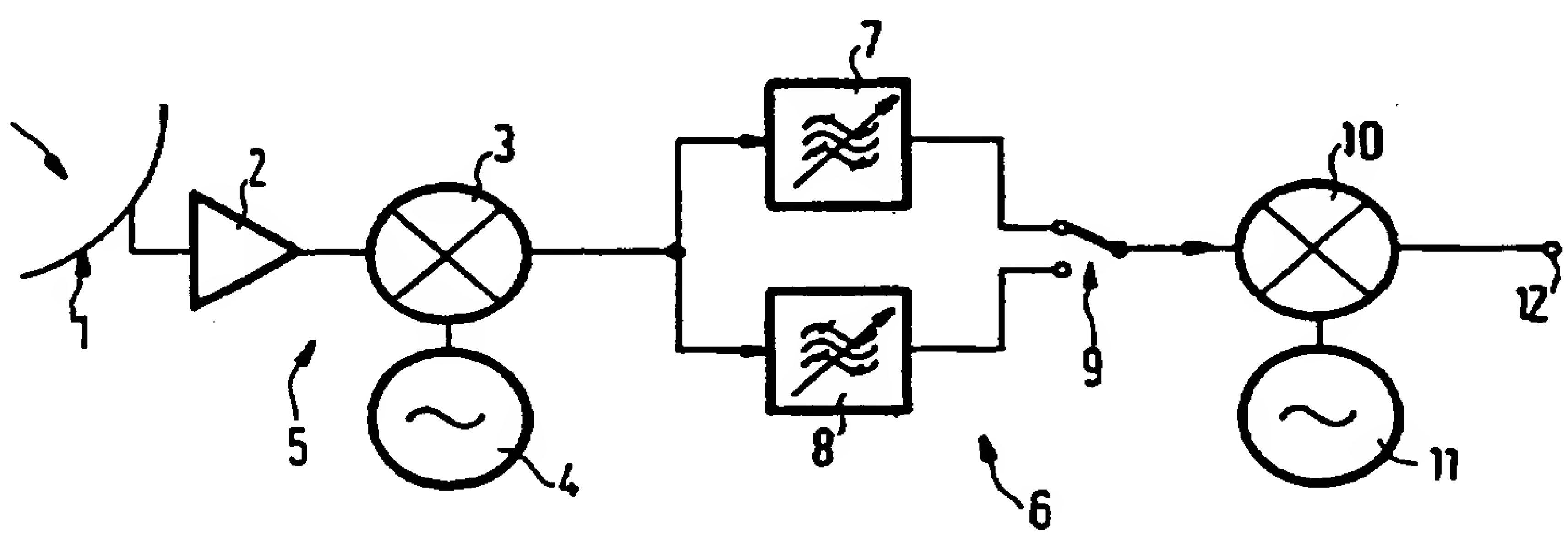

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB 94/00422

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04B 1/26, H03J 5/24, H03D 7/16
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H03D, H03J, H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0555132 A1 (ALCATEL TELSPACE), 11 August 1993 (11.08.93), column 2, line 5 - line 36; column 3, line 28 - line 52; column 4, line 53 - column 5, line 4, figures 1,2, abstract, column 6, line 8 - line 19 --	1,4,5
A	Patent Abstracts of Japan, Vol 6,No 99, E-111, abstract of JP, A, 57-31235 (HITACHI DENSHI K.K.), 19 February 1982 (19.02.82) --	1
A	DE 2651300 A1 (SONY CORP.), 18 May 1977 (18.05.77), page 8, line 6 - line 24, figure 2 --	2,3

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
31 July 1995	03-08-1995
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Bengt Jonsson Telephone No. +46 8 782 25 00

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0534278 A1 (THOMSON CONSUMER ELECTRONICS S.A.), 31 March 1993 (31.03.93), see the figure and claims --	1
A	US 4234965 A (ROBERT H. BICKLEY ET AL), 18 November 1980 (18.11.80), column 3, line 21 - line 65 -- --------	1

INTERNATIONAL SEARCH REPORT
Information on patent family members

29/05/95

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		JP-A- 5276066	22/10/93
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		CA-A- 1069629	08/01/80
		FR-A,B- 2331914	10/06/77
		GB-A- 1560387	06/02/80
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		US-A- 4132952	02/01/79
EP-A1- 0534278	31/03/93	AU-A- 2564992	27/04/93
		WO-A- 9306654	01/04/93
US-A- 4234965	18/11/80	NONE	